Set Name side by side	Query	Hit Count	Set Name result set
	DB=USPT; PLUR=YES; OP=ADJ		
L5	L3 and (resource$ adj1 provider$)	7	L5
L4	L3 and (resource$ with provider$)	20	L4
L3	L1 and (resource$ with management).ab.	174	L3
L2	L1 and (resource$ adj2 provision$ adj2 management$)	0	L2
L1	(705/$ OR 707/$ OR 709/$).CCLS.	31831	L1

END OF SEARCH HISTORY

WEST

Generate Collection

L5: Entry 1 of 7 File: USPT Oct 1, 2002

DOCUMENT-IDENTIFIER: US 6460082 B1
TITLE: Management of service-oriented resources across heterogeneous media servers using homogenous service units and service signatures to configure the media servers

Abstract Text (1):
A system and method for configuring service-oriented resources suitable for the resource management in a media server and more particularly, for resource configuration across distributed media servers. Heterogeneous media serves are configured in terms of homogeneous service-oriented resource units each used to represent a resource allocation commitment from a participating server for provisioning a particular media service on demand. A service unit associated with each different service supported by a media server represents an envelope of resource requirements as needed for provisioning a service. The method includes generating a resource envelope, and additionally compensating, at a media server, for differences between true resource utilization and resource envelope projected by a service unit. Each service unit also comprises a signature representing metadata used to control access to a service unit by defining rights, privileges, and characteristics of services that may use that particular server unit.

Detailed Description Text (15):
Similarly, a skilled artisan will appreciate that the meta-resource needs to be trusted by the remote authority and vice-versa. Security when accessing a meta-resource is important to the content subscriber. A mechanism is needed to enforce trust between the different parties. According to today's best practices, a key-exchange mechanism such as RSA may be used to handshake with a resource provider and authenticate the resource provider. Such mechanism is applicable to any other party. Security about the content being accessed is additionally important to the content provider. Thus, enforcement of copyrights and other forms of intellectual property protection over content is necessary. A skilled artisan will appreciate that this is a recognized need and means may be deployed to facilitate the enforcement of copyright between parties having different levels of trustiness. In particular, digital watermarking techniques may be used for safeguarding the copyrights of service objects.

Detailed Description Text (25):
Via access controls over capabilities and service units, the resource provider is now enabled to grant or deny access to the download of capabilities as well as the administration and configuration of its resources into service units.

Current US Original Classification (1):
709/226

Current US Cross Reference Classification (1):
709/223

Current US Cross Reference Classification (2):
709/224

Current US Cross Reference Classification (3):
709/225

US006460082B1

(12) **United States Patent**
Lumelsky et al.

(10) **Patent No.: US 6,460,082 B1**
(45) **Date of Patent: Oct. 1, 2002**

(54) **MANAGEMENT OF SERVICE-ORIENTED RESOURCES ACROSS HETEROGENEOUS MEDIA SERVERS USING HOMOGENOUS SERVICE UNITS AND SERVICE SIGNATURES TO CONFIGURE THE MEDIA SERVERS**

(75) Inventors: **Leon L. Lumelsky**, Stamford, CT (US); **Nelson R. Manohar**, New York, NY (US)

(73) Assignee: **International Business Machines Corporation**, Armonk, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/335,274**

(22) Filed: **Jun. 17, 1999**

(51) **Int. Cl.**[7] **G06F 15/173**
(52) **U.S. Cl.** **709/226**; 709/223; 709/224; 709/225
(58) **Field of Search** 709/223, 224, 709/225, 226, 328

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,442,791	A *	8/1995	Wrabetz et al.	709/330
5,826,239	A *	10/1998	Du et al.	705/8
5,999,525	A *	12/1999	Krishnaswamy et al.	370/352
6,058,423	A *	5/2000	Factor	709/226
6,085,030	A *	7/2000	Whitehead et al.	709/203
6,175,878	B1 *	1/2001	Seaman et al.	709/315
6,216,173	B1 *	4/2001	Jones et al.	709/328

FOREIGN PATENT DOCUMENTS

EP	0 674 280 A2	9/1995
EP	0 834 809 A2	4/1998
EP	0 848 334 A1	6/1998
WO	WO 92/1420	8/1992
WO	WO 93/20511	10/1993
WO	WO 98/15903	4/1998
WO	WO 99/44121	9/1999

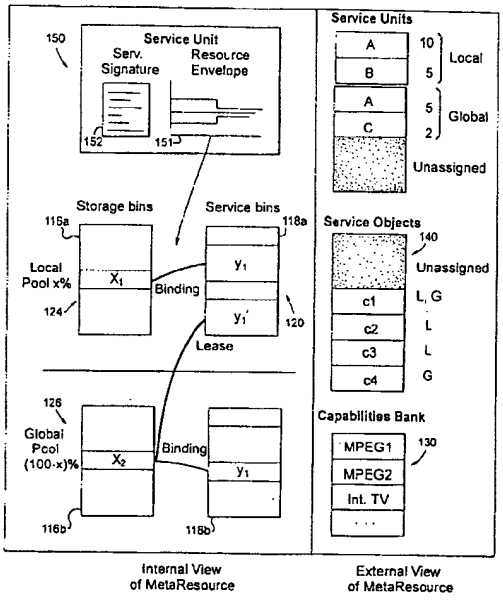
* cited by examiner

Primary Examiner—Zarni Maung
Assistant Examiner—Nabil El-Hady
(74) *Attorney, Agent, or Firm*—Scully, Scott, Murphy & Presser; Douglas W. Cameron

(57) **ABSTRACT**

A system and method for configuring service-oriented resources suitable for the resource management in a media server and more particularly, for resource configuration across distributed media servers. Heterogeneous media serves are configured in terms of homogeneous service-oriented resource units each used to represent a resource allocation commitment from a participating server for provisioning a particular media service on demand. A service unit associated with each different service supported by a media server represents an envelope of resource requirements as needed for provisioning a service. The method includes generating a resource envelope, and additionally compensating, at a media server, for differences between true resource utilization and resource envelope projected by a service unit. Each service unit also comprises a signature representing metadata used to control access to a service unit by defining rights, privileges, and characteristics of services that may use that particular server unit.

24 Claims, 8 Drawing Sheets



DOCUMENT-IDENTIFIER: US 6327541 B1
**** See image for Certificate of Correction ****
TITLE: Electronic energy management system

Abstract Text (1):
An electronic energy management system is suitable for use with an energy distribution network that provides energy from an energy resource to user sites. A plurality of energy usage meters, at least one at each user site, monitors energy usage at each user site. The system comprises a data acquisition subsystem that acquires energy usage data from the energy usage meters. The energy usage data comprises multiple increments of total energy usage over defined periods of time. An electronic data storage located at a central location remote from the energy usage meters stores the acquired energy usage data. An electronic communication subsystem provides user access to the stored acquired energy usage data from the electronic data storage.

Detailed Description Text (13):
One of the advantages of using a cellular system is that many energy resource providers have or likely will install cellular ready meters. Such cellular ready meters eliminate the need for manual meter reading. Moreover, customers that are outside of the cellular system, may still transmit their energy usage data via a telephone line or a similar communication device.

Current US Cross Reference Classification (1):
705/412

Current US Cross Reference Classification (2):
705/413

US006327541B1

(12) **United States Patent**
Pitchford et al.

(10) **Patent No.: US 6,327,541 B1**
(45) **Date of Patent: *Dec. 4, 2001**

(54) **ELECTRONIC ENERGY MANAGEMENT SYSTEM**

(75) Inventors: **Michael E. Pitchford**, Elsah, IL (US); **Thomas R. Voss**, Crestwood, MO (US)

(73) Assignee: **Ameren Corporation**, St. Louis, MO (US)

(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/108,024**

(22) Filed: **Jun. 30, 1998**

(51) **Int. Cl.**[7] **G06F 17/00**
(52) **U.S. Cl.** **702/62**; 705/413; 705/412
(58) **Field of Search** 705/412, 34, 400, 705/30.13, 413; 340/870.02, 870.03; 702/60, 61, 62; 324/127, 141, 142, 143; 700/295; 73/861.02, 861.03

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,705,385	*	12/1972	Batz	340/870.02
3,842,248	*	10/1974	Yarnell et al.	705/34
4,415,896	*	11/1983	Allgood	340/870.03
4,608,560		8/1986	Allgood .	
4,757,456		7/1988	Benghiat	705/412
4,799,156		1/1989	Shavit et al.	705/26
5,283,572	*	2/1994	McClelland et al.	340/870.02
5,315,531		5/1994	Oravetz .	
5,383,113		1/1995	Kight et al.	705/40
5,465,206		11/1995	Hilt et al.	705/40
5,483,455	*	1/1996	Pickering	705/40
5,495,239	*	2/1996	Ouellette	340/870.02
5,572,438	*	11/1996	Ellers et al.	700/295
5,590,197		12/1996	Chen et al.	705/65
5,649,117		7/1997	Landry	705/40
5,654,886		8/1997	Zereski, Jr. et al.	702/3
5,684,965		11/1997	Pickering	705/34
5,696,906		12/1997	Peters et al.	705/34
5,699,276		12/1997	Roos	379/106.3
5,699,528	*	12/1997	Hogan	705/40
5,710,889		1/1998	Clark et al.	345/344
5,724,525		3/1998	Beyers, II et al.	705/40
5,752,238		5/1998	Dedrick	705/14
6,088,659	*	7/2000	Kelley et al.	702/62
6,122,603	*	9/2000	Budike, Jr.	705/412

FOREIGN PATENT DOCUMENTS

2 107 093 A * 4/1982 (GB) .

OTHER PUBLICATIONS

Beaty, Wayne; Improved Metering equipment an d techniques cut costs; Feb. 1995; Electric Light and Power; DialogWeb copy pp. 1–7.*

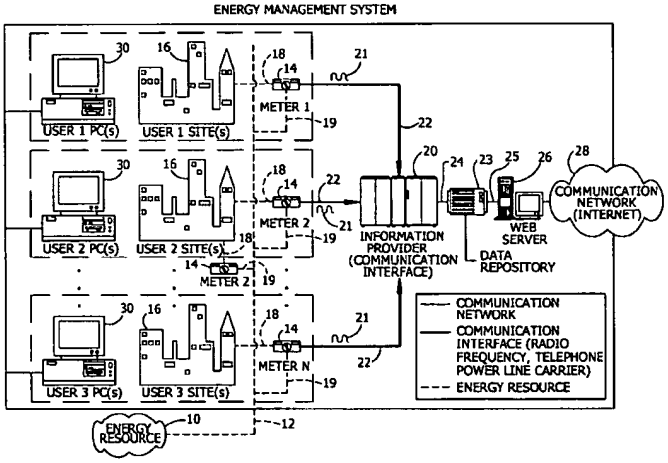
* cited by examiner

Primary Examiner—James P. Trammell
Assistant Examiner—Thomas A. Dixon
(74) *Attorney, Agent, or Firm*—Senniger, Powers, Leavitt & Roedel

(57) **ABSTRACT**

An electronic energy management system is suitable for use with an energy distribution network that provides energy from an energy resource to user sites. A plurality of energy usage meters, at least one at each user site, monitors energy usage at each user site. The system comprises a data acquisition subsystem that acquires energy usage data from the energy usage meters. The energy usage data comprises multiple increments of total energy usage over defined periods of time. An electronic data storage located at a central location remote from the energy usage meters stores the acquired energy usage data. An electronic communication subsystem provides user access to the stored acquired energy usage data from the electronic data storage.

30 Claims, 9 Drawing Sheets



L5: Entry 3 of 7 File: USPT Aug 28, 2001

DOCUMENT-IDENTIFIER: US 6282561 B1
TITLE: Method and system for resource management with independent real-time applications on a common set of machines

Abstract Text (1):
A resource management mechanism is provided to ensure that real-time application programs running on a single machine or set of machines exhibit predictable behavior. The resource management mechanism employs the abstraction of an activity which serves as the basis for granting resource reservations and for accounting. An activity submits a request for resources in specified amounts to a resource planner. The activity is resource self-aware so that it is aware of its resource requirements. The activity may query resource providers to obtain resource requirements for particular operations. The resource planner determines whether the activity should be granted the requested reservation by employing an internal policy. Policy is separated by mechanism so that the resource planner may implement any of a number of policies. The resource planner may choose to grant the reservation to an activity or deny the request by an activity. When denying a request, the resource planner may inform the activity of what quantity of the requested resources are currently available so that the activity may submit a modified request. The resource management mechanism includes a dynamic feedback mechanism for initiating renegotiation of resource reservations when appropriate.

Brief Summary Text (14):
In accordance with an additional aspect of the present invention, a first resource provider that manages access to a resource is queried. This first resource provider is called by an activity to perform an operation on behalf of the activity. The activity queries the first resource provider to determine a first set of resource requirements to perform the operation on behalf of the activity. The first resource provider, in turn, queries a second resource provider that is called by the first resource provider to complete the operation on behalf of the activity. The querying is used to determine a second set of resource requirements for the second resource provider to perform its role in the operation that is performed on behalf of the activity. The first set of resource requirements is determined to be a sum of the second set of resource requirements and any additional resource requirements for actions directly performed by the first resource provider to complete operation on behalf of the activity. The resource requirements of the activity are determined to be a sum of the first set of resource requirements and any additional resource requirements of the activity.

Drawing Description Text (5):
FIG. 3 is a block diagram illustrating an example of an activity querying resource providers to determine resource requirements in accordance with the preferred embodiment of the present invention.

Drawing Description Text (12):
FIG. 7C is a flowchart illustrating the steps that are performed to realize a renegotiation when a resource provider detects a persistent overload condition.

Detailed Description Text (3):
A "resource," as used herein, refers to a limited hardware or software quantity that is provided by a machine. Examples of resources include CPU time, memory capacity, I/O bus bandwidth, network bandwidth, and devices, such as video frame buffers and sound cards. Resources may also encompass higher level software-defined resources that manage other resources. Resources are represented in the preferred embodiment of the present invention by objects that manage the resources. These objects are

referred to as "resource providers." As will be described in more detail below, resource providers support operations such as allocating amounts of the resources, performing resource accounting, and providing notifications.

Detailed Description Text (7):
FIG. 1 is a block diagram depicting a computer system 10 that is suitable for practicing the preferred embodiment of the present invention. The computer system 10 includes a central processing unit (CPU) 12 that has access to a primary memory 14 and a secondary storage 16. The primary memory 14 holds a copy of an operating system 18 that is well adapted for running real-time application programs 20 and 22. The operating system 18 provides an object-oriented environment and supports the Microsoft OLE 2.01 protocol. The operating system 18 also includes support for creating a resource planner 24. The primary memory 14 additionally holds a number of resource providers 26 corresponding to the local resources of the computer system 10. The computer system 10 may further include an input/output (I/O) device 28 and a network adapter 30 that connects the computer system 10 with a computer network 32, such as the Internet.

Detailed Description Text (9):
As was mentioned above, in the preferred embodiment of the present invention real-time application programs are resource self-aware. The application programs 20 and 22 know what resources, as well as how much of those resources, they need to have to run properly and predictably. FIG. 2 is a flowchart illustrating the steps that are performed when an activity that is associated with an application program seeks to reserve resources. Initially, the activity determines what resources it needs (step 34 in FIG. 2). This determination involves an information gathering process. In the preferred embodiment of the present invention, the activity queries resource providers to determine what resources the activity needs. The activity is aware of what resource providers it uses, and the activity queries the resource providers it uses to determine what resources are, in turn, needed by those resource providers to perform their job and what quantities of resources are required for the resource providers to perform their job.

Detailed Description Text (10):
In order to more fully understand the information gathering process, it is helpful to understand how the resource providers are logically organized. First, it should be appreciated that the resource providers are modularized. Resource providers may be components of larger modules. An example helps to illustrate this modularity. FIG. 3 depicts an example where an activity 60 needs to exploit disk bandwidth and network bandwidth to perform a network write operation. The activity knows that it must use the file system and the network to perform such a write operation. The file system has an associated file system resource provider 50, and the network has an associated network resource provider 56. In performing the disk read operation, the file system resource provider 50 recognizes that it must call upon the SCSI disk resource provider 52 and the I/O bus resource provider 54 to perform the disk read operation. The network resource provider similarly recognizes that it must call upon the I/O bus resource provider 54 and the asynchronous transfer mode (ATM) adapter 58 to perform the network write operation. Thus, the activity 60 realizes it must use disk bandwidth and network bandwidth, but the activity 60 relies upon the file system resource provider 50 and the network resource provider 56 to determine what additional resources are required to obtain the disk bandwidth and network bandwidth, respectively.

Detailed Description Text (11):
Software components that have real-time resource requirements provide interfaces that expose those requirements to their clients. This allows the clients to query the components about the resources that are needed to perform operations that the client will use. In other words, resource providers support interfaces that allow clients of the resource providers to determine what resources are required for particular operations. An interface, as used herein, is a Microsoft OLE 2.01 interface and refers to a named group of semantically related methods. Objects that implement the code for all of the methods in an interface are said to "support" the interface. Examples of interfaces supported by resource providers that may be queried to obtain resource requirements are the IFileSys, IScsiDisk, IIOBus, INetwork and IAtmCard interfaces shown in FIG. 3.

Detailed Description Text (12):
FIG. 4 is a flowchart that illustrates the steps that are performed to determine what resources an activity needs (step 34 in FIG. 2). The activity queries the resource providers in a modular fashion (step 64 in FIG. 4). The queries are represented in FIG. 3 by arrows 59A, 59B, 59C, 59D, 59E and 59F. The queries are implemented as calls to methods in interfaces supported by the resource providers. The activity 60 sums the resources required by each of the resource providers it calls and adds any resources required by operations that it directly implements. Thus, for example in FIG. 3, the file system resource provider 50 is a client of the SCSI disk resource provider 52 and the I/O bus resource provider 54. The resource requirements of the file system resource provider 60 to perform the network read operation requested by the activity 60 includes the resource requirements of both the SCSI disk resource provider to perform its role in the operation, the resource requirements of the I/O bus resource provider 54 to perform its role, and the separate resource requirements of the file system resource provider 50. The resource requirements of the activity 60 are the cumulative resource requirements of the file system resource provider 50 and the network resource provider 56 in performing the network read operation. The resource requirements of the file system resource provider 50 and the network resource provider 56 reflect resource requirements of the modular components that are called by those resource providers. Thus, in step 66 of FIG. 4, the resources requirements of the modules are summed along with the direct resource requirements to determine the cumulative resource requirements for the activity.

Detailed Description Text (19):
Enforcement of the resource allocations in the preferred embodiment of the present invention is voluntary. It is assumed that an activity will comply with the decision of the resource planner 62 because the activity wishes to exhibit predictable performance. If the resource planner 62 indicates that the resources are not available and an activity decides to proceed anyway, it is likely that the activity will encounter serious problems while executing. The preferred embodiment also provides a mechanism for a resource to make known when a persistent overload condition exists. The resource provider may fail operations that exceed reservations. The resource planner may then force a renegotiation of resource reservations to more equitably distribute resource allocation. In other words, enforcement is voluntary but safety mechanisms are provided to help ensure good behavior.

Detailed Description Text (20):
As part of the process of granting resources to an activity 60, the resource planner 62 must contact each of the resource providers to reserve the appropriate portion of the resources that has been granted to the activity. Each resource, by definition, must support the IResource interface. This interface is formally defined as follows:

Detailed Description Text (21):
The Reserve( ) method allows the resource planner 62 to reserve a certain quantity of the resource. Hence, for the example shown in FIG. 5, the resource planner 62 makes calls 72A, 72B, 72C, 72D and 72E to call the Reserve( ) methods of the IResource interfaces supported by the resource providers 50, 52, 54, 56 and 58, respectively.

Detailed Description Text (27):
The reassignment of resource reservations is realized by either direct resource provider action or by prompting renegotiations by lower importance activities. FIG. 6B is a flowchart illustrating the steps that are performed in performing step 82 of FIG. 6A. Typically, the resource planner notifies the lower importance activity that another activity needs some of the resources it is using more than the informed activity does (step 75 in FIG. 6B). The resource planner performs such notification by calling a method on the IActivityNotify interface which each activity supports. This interface is formally defined as follows.

Detailed Description Text (29):
Alternatively, the resource planner may directly intervene when activities are

poorly behaved. In such an instance, a time-out occurs (step 79 in FIG. 6B), and the resource planner directly calls resource providers on behalf of an activity to change the resource reservations for the activity (step 81 in FIG. 6B). Specifically, the resource planner calls the Reserve( ) method to alter the resource reservations of the lower importance activities that are poorly behaved to relinquish the resources for use by the higher importance activities.

Detailed Description Text (33):
A final type of event that may trigger resource reservation renegotiation arises when a resource provider experiences persistent overload. FIG. 7C is a flowchart that illustrates the steps that are performed in such an instance. Initially, the resource provider detects a persistent overload condition (step 98 in FIG. 7C). The resource provider then contacts the resource planner to inform the resource planner of the persistent overload condition (step 100 in FIG. 7C). The resource planner may inform an activity that it has consistently overused a resource and initiate a renegotiation by calling the OnOverload( ) method of the activity. The renegotiation process is subsequently performed (step 102 in FIG. 7C).

Detailed Description Text (34):
The above-described examples have dealt with instances where activities request local resources. The preferred embodiment of the present invention also enables activities to request remote resources. This capability is in large part realized by maintaining separate but cooperating resource planners on each computer system within a distributed environment. For example, as shown in FIG. 8, each of the computer systems 104 in the illustrated distributed environment includes its own resource planner 106 that is responsible for managing the resources that are local to the computer systems 104. Each computer system 104 includes local resource providers 108 that are associated with local resources and managed by the local resource planner 106.

Current US Original Classification (1):
709/104

Current US Cross Reference Classification (1):
709/315

CLAIMS:

1. In a computer system that runs processes having threads, said computer system having resources for use by the processes and threads, an object-oriented method comprising:

defining multiple resource provider objects to manage associated resources, at least some of the resource provider objects depending on and being configured to query other resource provider objects to determine what additional resources are needed for an activity;

querying resource provider objects to determine what resources are needed for a cross-process activity, the cross-process activity representing an abstraction of a running program that spans multiple thread and process boundaries to include portions of multiple processes;

determining, responsive to said querying, resource needs of the cross-process activity;

calling a resource planner object with a request to reserve a share of at least one resource to meet the resource needs of the cross-process activity;

receiving at the resource planner object the request;

processing the request with the resource planner object; and

granting the request on a per-activity basis so that the share of the at least one resource is reserved for use by the cross-process activity.

8. In a computer system having resources for use by cross-process activities and a resource planner for granting reservations for shares of the resources, individual cross-process activities representing an abstraction of a running program that spans multiple thread and process boundaries to include portions of multiple processes, an object-oriented method comprising:

defining a plurality of resource provider objects to manage a plurality of respective resources;

running a cross-process activity on the computer system, wherein the cross-process activity is aware of the resource provider objects that it uses;

calling individual resource provider objects that are used by the cross-process activity to query them to determine resources that are needed by the cross-process activity, said calling comprising at least one resource provider object calling another resource provider object on whose resource it depends, to determine what additional resources are needed for the cross-process activity;

calling a resource planner object with a request to obtain a reservation for a share of at least one of the resources, the request containing the resource requirements of the activity; and

processing the request in the resource planner object to grant or deny the request.

10. In a computer system that runs processes having threads, said computer system having resources for use by the processes and threads, a resource planner for granting reservations of shares of the resources, and a plurality of resource providers that manage resources, an object-oriented method comprising:

determining what resources an activity needs by calling one or more methods in interfaces supported by multiple resource provider objects that represent respective resources that are needed by the activity, at least one call being made by one resource provider object to another resource provider object, the activity representing an abstraction that serves as a generalization of a running program and is a unit of abstraction to which resources are allocated and against which resource usage is charged, and further wherein the resources comprise limited software quantities;

calling a resource planner object interface to send a request to obtain a reservation for a share of at least one of the resources which was determined to be needed by the activity;

receiving at the resource planner object the request for the activity to reserve a share of at least one resource, wherein the activity includes at least portions of multiple processes; and

processing the request in the resource planner object to grant or deny the request.

11. The method of claim 10, wherein said calling of at least one interface on at least one resource provider object comprises calling an interface on a plurality of resource provider objects in modular fashion.

12. The method of claim 10, wherein the resource provider objects support a common interface, and wherein the calling of the resource planner object comprises including a reference to the common interface that is supported by a particular resource provider object.

13. The method of claim 12, wherein the calling of the resource planner object comprises including a resource set which includes a number of pairs of resources and resource amounts, and wherein each pair of a resource set includes a reference to the common interface supported by the particular resource provider object.

14. The method of claim 1 further comprising querying, with at least one resource provider object, another resource provider object on which the one resource provider object depends, to determine what additional resources are required.

15. The method of claim 14, wherein said queryings are implemented as calls to methods in interfaces supported by the resource provider objects.

US006282561B1

(12) **United States Patent**
Jones et al.

(10) **Patent No.: US 6,282,561 B1**
(45) **Date of Patent: *Aug. 28, 2001**

(54) **METHOD AND SYSTEM FOR RESOURCE MANAGEMENT WITH INDEPENDENT REAL-TIME APPLICATIONS ON A COMMON SET OF MACHINES**

(75) Inventors: **Michael B. Jones**, Redmond; **Paul J. Leach**; **Richard P. Draves, Jr.**, both of Seattle, all of WA (US); **Joseph S. Barrera, III**, Belmont, CA (US)

(73) Assignee: **Microsoft Corporation**, Redmond, WA (US)

(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **08/568,578**

(22) Filed: **Dec. 7, 1995**

(51) **Int. Cl.**[7] **G06F 9/00**

(52) **U.S. Cl.** **709/104**; 709/315

(58) **Field of Search** 395/673, 674, 395/675, 200.56, 200.57, 200.58, 200.59, 200.33, 200.34; 709/104, 103, 105, 203–204, 227–229; 717/10

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,481,583	*	11/1984	Mueller	364/300
4,890,227	*	12/1989	Watanabe et al.	364/300
5,303,369	*	4/1994	Borcherding et al.	395/650

(List continued on next page.)

OTHER PUBLICATIONS

J. Huang, et al "Resource Management for Continuous Multimedia Database Applications", IEEE onDisc, pp. 46–54, 1994.*

D, Anderson et al, "Support for Continuous Media in the DASH System", IEEE onDisc, pp. 54–61, 1990.*

D. Anderson, "Metascheduling for Continuous Media", ACM Transac. Computer Systems, vol. 11, No. 3, Aug. 1993.*

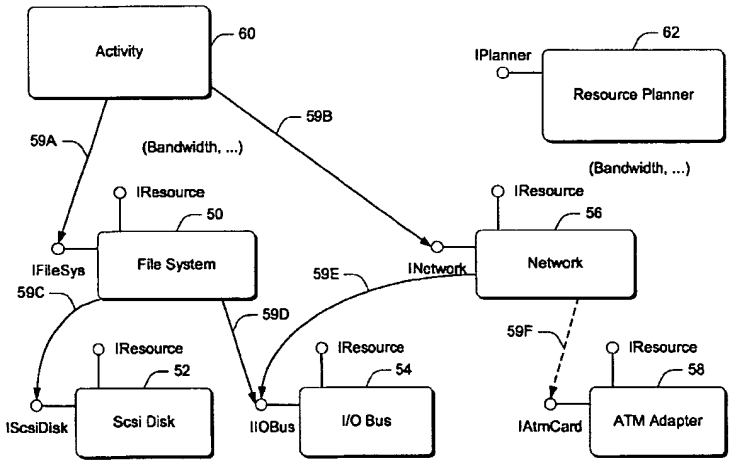
(List continued on next page.)

Primary Examiner—Majid A. Banankhah
Assistant Examiner—Sue Lao
(74) *Attorney, Agent, or Firm*—Lee & Hayes, PLLC

(57) **ABSTRACT**

A resource management mechanism is provided to ensure that real-time application programs running on a single machine or set of machines exhibit predictable behavior. The resource management mechanism employs the abstraction of an activity which serves as the basis for granting resource reservations and for accounting. An activity submits a request for resources in specified amounts to a resource planner. The activity is resource self-aware so that it is aware of its resource requirements. The activity may query resource providers to obtain resource requirements for particular operations. The resource planner determines whether the activity should be granted the requested reservation by employing an internal policy. Policy is separated by mechanism so that the resource planner may implement any of a number of policies. The resource planner may choose to grant the reservation to an activity or deny the request by an activity. When denying a request, the resource planner may inform the activity of what quantity of the requested resources are currently available so that the activity may submit a modified request. The resource management mechanism includes a dynamic feedback mechanism for initiating renegotiation of resource reservations when appropriate.

15 Claims, 12 Drawing Sheets



L5: Entry 4 of 7 File: USPT Jul 11, 2000

DOCUMENT-IDENTIFIER: US 6088688 A
**** See image for Certificate of Correction ****
TITLE: Computerized resource accounting methods and systems, computerized utility management methods and systems, multi-user utility management methods and systems, and energy-consumption-based tracking methods and systems

Abstract Text (1):
Computerized resource accounting methods and systems, and in particular computerized utility resource management methods and systems, multi-user utility resource management methods and systems, and energy-consumption-based tracking methods and systems are described. In one implementation, a host computer includes a processor, an interface device and a database defined therein for maintaining information

Brief Summary Text (4):
A resource can be considered as a good, service, and/or commodity which is purchased by a customer and sold by a resource provider. Oftentimes a customer will purchase many different types of resources from numerous providers under differing pricing structures, and desire to account for, or otherwise track its resource consumption. This can be for various reasons which include a desire to budget for resource purchasing, track current and past usage and expenditures, and to predict future usage and expenditures.

Brief Summary Text (5):
One type of resource is a utility resource. Utility resources typically include electricity, gas (natural or petroleum-based), water, and sewer service, to name just a few. One type of customer for utility services is one which includes a number of different geographically-separated sites. Such customers typically purchase their resources from multiple unrelated resource providers. Those who have purchase decision making and/or payment authority for these types of resources typically face a very burdensome task of tracking and maintaining resource consumption and use information for a customer, and in particular for a customer having a number of different sites. In the past, tracking and accounting for resource consumption has typically been done by each individual customer. Needless to say, this is a very time-consuming and expensive proposition.

Detailed Description Text (4):
In a preferred implementation, a central database is developed and contains information pertaining to different corporate and/or individual facilities. Information such as billing history for resource usage, structure information (such as square footage and structure characteristics), servicing resource provider and/or utility resource providers, and resource account information can be, and preferably is incorporated into the database. Other types of information can be incorporated, as will become apparent below.

Detailed Description Text (6):
In accordance with one aspect of the invention, billing information which is received from each resource provider is scrutinized in if accordance with a plurality of predefined or pre-determined tolerance parameters. Any information which does not meet with one or more of the tolerance parameters can be flagged for remedial processing. In accordance with a preferred aspect of the invention, scrutinization is performed by the host computer in accordance with a variety of algorithmic checks which are implemented in software. The tolerance parameters are preferably calculated through utilization of the billing information for each resource provider.

Detailed Description Text (14):
In view of the foregoing computer system description and in accordance with one aspect of the invention, the reader is referred to FIG. 2. There, an exemplary computer system or host system 20 can be seen to comprise part of a system which includes a resource provider 32 and a customer 34. In the context of this document, the term "resource provider" will be understood to include a company or other source from which resources in the form of goods, services and/or commodities originate. In a preferred implementation, such resource provider can comprise one or more resource providers, e.g. providers of electricity, water, sewage services, natural gas, propane, alternate energy sources and/or other related goods or services or processes. Similarly, the term "customer" as used in this document will be understood to include an individual, company, companies or sites which consume resources from one or more resource providers. In a preferred implementation, such customers consume one or more utility resources for which it is desired to account.

Detailed Description Text (16):
At step 220 (FIG. 5) resource usage information from resource provider 32 is received into host computer 22. The resource usage information pertains to consumption of at least one resource by the customer. The resource usage information can be introduced into system 20 in any suitable way. In one embodiment, such information from resource provider 32 is received electronically, via a suitable data link with host computer 20, using one or more of the Internet protocols mentioned above. Alternately, resource usage information can be received in hard-copy form and entered into the host computer as by manual data entry. Other methods and systems can, of course, be utilized to permit such information to be received by host computer 20.

Detailed Description Text (19):
In one aspect of the invention, an audit process is provided at step 240 (FIG. 5). The audit process is preferably implemented in a suitable software application which is resident upon the hardware platform defined by host computer 22. Audit process 240 includes a definition step, at step 250, wherein at least one, and preferably more pre-determined tolerance parameters are defined. At step 260, the resource usage information which is received from resource provider 32 is checked against the pre-determined tolerance parameter(s) for determining whether the information satisfies such parameter(s). If the resource usage information does not satisfy the pre-determined tolerance parameter, then, in accordance with one aspect of the invention, the information from the resource provider is flagged for remedial processing, either manually or electronically, which includes error checking the information.

Detailed Description Text (24):
Customer 34 can be subsequently provided with remote electronic access to the viewable data preferably through the interface device 30 (FIG. 1). Remote access is preferably provided through a remote computer, such as the one shown in FIG. 6, which is linkable with host computer 22 through a protocol, such as one suitable for use within an Internet-based system. In particular, and in connection with a preferred implementation, host computer 22 provides or otherwise defines an Internet website. The various usage information received and processed by host computer 22 from resource provider 32 is provided on the Internet site and can be remotely accessed by the customer. Preferably, access to information contained on host computer 22 is password-protected such that only the intended customer can access its relevant information. In this way, centralized, computer-accessible, resource accounting methods and systems are provided which are "proactive" in the sense that the customer can, on its own time and terms, access its relevant usage-based information. Further, an audit process is provided to scrutinize the resource usage information to ensure that the information utilized to generate the computer-viewable data is within acceptable tolerances levels.

Detailed Description Text (25):
Referring to FIG. 3, an implementation in accordance with another aspect of the invention is set forth generally at 36. In this implementation, a plurality of resource providers 38, 40, 42, and 44 provide resource usage information to host computer 20 such that the host computer can process the information as described immediately above. The resource providers need not be related to one another and can

comprise separate companies. Alternately, the resource usage information provided by resource providers 38-44 can originate from one resource provider and can constitute a plurality of different resources, e.g. electric power, water, natural gas, sewer services, and the like. Such would be the case, for example, if one resource provider were to provide all of the pertinent resources which are utilized by a particular consumer. Of course, the above-described tolerance parameters which are effectuated through the audit processor function can be, and preferably are implemented for the resource usage information which is received from each of the resource providers.

Detailed Description Text (27):
Again, centralized, computer-accessible, interactive resource management methods and systems are provided which are "proactive" in the sense that the customer can, on its own time and terms, access its relevant resource usage information. Further, a system is provided which can receive resource usage input from a number of different resource providers. Further still, a system is provided which can tolerance check the resource usage information received from each of the resource providers to ensure accurate reporting thereof to the customer. Accordingly, very streamlined, efficient, and accurate resource management and accounting systems and processes are provided by the various implementations of the invention.

Detailed Description Text (28):
Referring to FIG. 4, another implementation in accordance with the invention is set forth generally at 46. There, it can be seen that a plurality of resource providers 38-44 have access to, or are otherwise capable of providing resource usage information to computer system 20. A plurality of customers 48, 50, 52, and 54 preferably have remote electronic access to computer system 20 in much the way as was described above. It is to be understood that although only four resource providers and four customers are utilized in the illustration, many more of both are contemplated.

Detailed Description Text (29):
In this example, a database within host system 20 receives and stores information associated with each of customers 48-54. Resource usage information is received into host computer 20 from resource providers 38-44. Such information, for each of both the resource providers and the customers, is preferably tolerance checked as described above, to ensure the accuracy of such information. Such information is further preferably processed into computer-viewable, usage-based data associated with each customer's consumption of the resource. In a preferred embodiment, the resource comprises a utility resource. Preferably a plurality of different utility resources are managed and tracked by the inventive systems and methodologies. Such processed information is preferably made available, through remote computer terminal access, to each of the customers.

Detailed Description Text (30):
Again, computer-accessible, interactive resource management methods and systems are provided which are "proactive" in the sense that the consumer can, on its own time and terms, access its relevant resource usage information. Further, a system is provided which receives resource usage information from a number of different resource providers, checks the resource usage information against one or more tolerance parameters, processes such information and makes it available to the customers via electronic link. In this implementation a plurality of different customers are incorporated into the system of the present invention. Accordingly, very streamlined, accurate, and efficient systems and processes are provided by the various implementations of the invention.

Detailed Description Text (32):
database as described above. Each customer can, but need not, comprise a plurality of different sites which may or may not be geographically separated. The customers are customers and consumers of utility resources provided by a plurality of different utility resource providers 64, 66, 68, and 70. Each customer may, however, be a customer of only one utility resource provider. Alternately, each customer may be a customer of more than one utility resource provider. Where a customer has many different geographically-separated sites, utility resources such as electricity, water, gas, and/or other related utility resource services could conceivably be

provided by a large number of utility resource companies or providers. Utility resource usage information is received from each utility resource company into host computer 22 as described above in connection with step 220 (FIG. 5). The usage information pertains to consumption of utility resources by each site of each customer and includes, as mentioned above, cost-related and quantity-related consumption variables. Such information is preferably tolerance checked in accordance with the above-described audit processor to ensure the accuracy thereof. Preferably, tolerance checking is performed for each of the utility resource providers for each of their relevant customers. Such information is preferably subsequently processed as described and customers 58-62 are provided with remote electronic access to computer-viewable data in host computer 20 through interface device 30 (FIG. 1) as described above. Such computer-viewable data is preferably in the form of a plurality of different graphical reports which can be selected by the customer for viewing on a computer which is remote from the host computer.

Detailed Description Text (33):
The inventive methodologies and systems described just above are particularly useful in the context of utility resource customers having a number of different, geographically-separated sites (such as nationwide) which are serviced by a plurality of different utility resource providers.

Detailed Description Text (34):
For example, and with reference to FIG. 7, customer 58 includes sites 58a, 58b, and 58c. Although only three exemplary sites are used, it will be understood that such sites can comprise any number of different sites which may or may not be geographically-separated. Similarly, customer 60 includes site 60a, 60b, and 60c. Likewise, customer 62 includes site 62a, 62b, and 62c. For purposes of example only, assume that each geographically-separated site of any of the customers is serviced by a different utility resource provider or company. Each utility resource provider is able to, through the inventive methodologies and systems, provide usage information for each specific geographically-separated site to computer system 20. Such information is received and processed and provided so that each customer, e.g. customers 58, 60, 62, can access and view graphical reports, including numerical and tabulated reports, for each of its sites. In this embodiment, as was briefly mentioned above, the tolerance parameters can be, and preferably are defined to be utility-specific. This gives the customer access to processed, computer-viewable data which includes a desired degree of utility pricing expertise. Such expertise is comprehensive and vast insofar as a large number of utility resource providers are incorporated into the system for an even larger number of customers. Through the preferred tolerance parameter checking, errors or anomalies can be easily detected for correction. In the context of utility providers, customers whose utility usage information is determined to fail one or more of the tolerance parameters can receive an adjustment from the servicing utility, or alternately, can be placed on a correct rate schedule. Alternatively, and in the event there is no error in the usage information, the customer can be advised to modify utility consumption to qualify for a more favorable price, or, may be advised to seek an alternate supplier whose pricing may be more favorable for the customer's existing consumption pattern.

Detailed Description Text (83):
Referring to FIGS. 51, 52A-52B an exemplary screen 192 is shown and describes an aggregated load profile which has been aggregated for the subject time interval. This report gives the customer the added flexibility to uniquely tailor the aggregation report to suit the customer's needs. For example, a customer can select, for aggregation, a date or date range, how aggregation is to be made (i.e., "Total Company", "Region", "State", or by "Utility" or Utility Resource Provider) as shown in FIG. 52A. A plurality of different regions, such as the illustrated "Southwest" region can be selected. Regions can also be thought of as climate zones, business operations areas, and the like. In addition, a customer can select to include or exclude one or more sites from aggregation. In addition to the load profile aggregation, a tabular summary (FIG. 52B) can be provided to give the customer hard numbers describing the particular aggregated period. For example, a summary describes an average, peak, and low demand figure for each day within the period. The summary also identifies load factor and the total kilowatt hours for the particular period. Such quantities are particularly useful in assisting the customer

in quantifying and identifying the characteristics of their loads, and providing invaluable information to energy suppliers, i.e. utility resource providers, that serve the customers in a deregulated environment. A customer can also, through a drill-down option, click on a particular day and see that day's aggregated profile 194 as shown in FIG. 53.

Current US Original Classification (1):
705/412

Current US Cross Reference Classification (3):
705/400

Current US Cross Reference Classification (4):
707/104.1

Current US Cross Reference Classification (5):
709/217

Current US Cross Reference Classification (6):
709/219

US006088688A

United States Patent [19]

Crooks et al.

[11] Patent Number: 6,088,688

[45] Date of Patent: *Jul. 11, 2000

[54] **COMPUTERIZED RESOURCE ACCOUNTING METHODS AND SYSTEMS, COMPUTERIZED UTILITY MANAGEMENT METHODS AND SYSTEMS, MULTI-USER UTILITY MANAGEMENT METHODS AND SYSTEMS, AND ENERGY-CONSUMPTION-BASED TRACKING METHODS AND SYSTEMS**

[75] Inventors: **Gerry Crooks**; **Ed Arnhold**; **John Battista**, all of Spokane, Wash.; **Ken Boni**, Hayden Lake; **Dan Bowers**, Boise, both of Id.; **Mark Feichtner**, Spokane, Wash.; **Blaine French**, Spokane, Wash.; **Janna Genzberger**, Spokane, Wash.; **David D. Holmes**, Colbert, Wash.; **Larry Kippenhan**, Greenacres, Wash.; **Dave Miller**; **Shawn Nanto**, both of Spokane, Wash.; **Teri Orr**, Greenacres, Wash.; **Ed Schlect**, Spokane, Wash.

[73] Assignee: **Avista Advantage, Inc.**, Spokane, Wash.

[*] Notice: This patent is subject to a terminal disclaimer.

[21] Appl. No.: **09/290,016**

[22] Filed: **Apr. 8, 1999**

Related U.S. Application Data

[63] Continuation of application No. 08/992,678, Dec. 17, 1997, Pat. No. 5,930,773.

[51] **Int. Cl.**[7] **G06F 17/60**

[52] **U.S. Cl.** **705/412**; 702/61; 702/62; 705/400; 707/104; 709/217; 709/219

[58] **Field of Search** 395/200.47, 200.48, 395/200.49; 702/60, 61, 62; 705/400, 412, 413, 414; 707/104; 709/217, 218, 219

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,852,571 12/1974 Hall et al. ..... 235/61.7 B
4,485,300 11/1984 Peirce 235/380
4,701,601 10/1987 Francini et al. 235/449

(List continued on next page.)

FOREIGN PATENT DOCUMENTS

WO 97/20278 6/1997 WIPO .
WO 97/24688 7/1997 WIPO .
WO 97/48161 12/1997 WIPO .

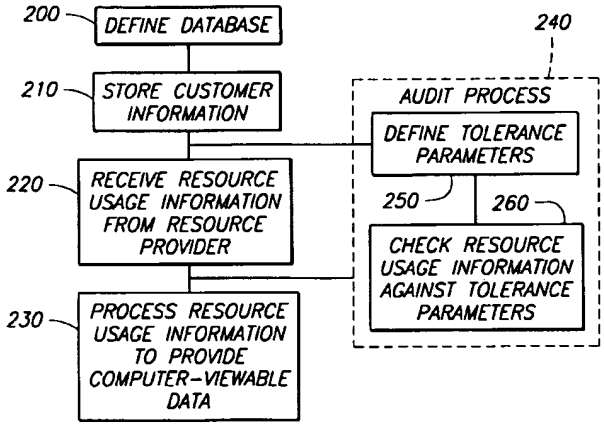
(List continued on next page.)

Primary Examiner—Edward R. Cosimano
Attorney, Agent, or Firm—Wells, St. John, Roberts, Gregory & Matkin, P.S.

[57] **ABSTRACT**

Computerized resource accounting methods and systems, and in particular computerized utility resource management methods and systems, multi-user utility resource management methods and systems, and energy-consumption-based tracking methods and systems are described. In one implementation, a host computer includes a processor, an interface device and a database defined therein for maintaining information pertaining to one or more customers of one or more resources. Resource usage information is received into the host computer pertaining to consumption of one or more of the resources by one or more of the customers at one or more customer site. The resource usage information is processed to provide usage-based, computer-viewable data associated with a respective customer's consumption of one or more of the resources. In a preferred aspect, each customer is provided with computer access to the computer-viewable data through the interface device, wherein the customer can view the data at a location which is remote from the host computer. Preferably, the computer-viewable data comes in the form of a plurality of different graphical reports, including numerical and tabulated reports, which can be selected by a customer. For customers with multiple sites, the viewable data for the various sites can be viewed remotely and in a plurality of different report formats. In a preferred implementation, utility resource usage information, e.g. electricity, gas, water, etc . . . , is tracked, maintained, and made available to facilitate decision making.

7 Claims, 78 Drawing Sheets



WEST

Generate Collection

L5: Entry 5 of 7 File: USPT Jul 27, 1999

DOCUMENT-IDENTIFIER: US 5930773 A
TITLE: Computerized resource accounting methods and systems, computerized utility management methods and systems, multi-user utility management methods and systems, and energy-consumption-based tracking methods and systems

Abstract Text (1):
Computerized resource accounting methods and systems, and in particular computerized utility resource management methods and systems, multi-user utility resource management methods and systems, and energy-consumption-based tracking methods and systems are described. In one implementation, a host computer includes a processor, an interface device and a database defined therein for maintaining information pertaining to one or more customers of one or more resources. Resource usage information is received into the host computer pertaining to consumption of one or more of the resources by one or more of the customers at one or more customer site. The resource usage information is processed to provide usage-based, computer-viewable data associated with a respective customer's consumption of one or more of the resources. In a preferred aspect, each customer is provided with computer access to the computer-viewable data through the interface device, wherein the customer can view the data at a location which is remote from the host computer. Preferably, the computer-viewable data comes in the form of a plurality of different graphical reports, including numerical and tabulated reports, which can be selected by a customer. For customers with multiple sites, the viewable data for the various sites can be viewed remotely and in a plurality of different report formats. In a preferred implementation, utility resource usage information, e.g. electricity, gas, water, etc. . . , is tracked, maintained, and made available to facilitate decision making.

Brief Summary Text (4):
A resource can be considered as a good, service, and/or commodity which is purchased by a customer and sold by a resource provider. Oftentimes a customer will purchase many different types of resources from numerous providers under differing pricing structures, and desire to account for, or otherwise track its resource consumption. This can be for various reasons which include a desire to budget for resource purchasing, track current and past usage and expenditures, and to predict future usage and expenditures.

Brief Summary Text (5):
One type of resource is a utility resource. Utility resources typically include electricity, gas (natural or petroleum-based), water, and sewer service, to name just a few. One type of customer for utility services is one which includes a number of different geographically-separated sites. Such customers typically purchase their resources from multiple unrelated resource providers. Those who have purchase decision making and/or payment authority for these types of resources typically face a very burdensome task of tracking and maintaining resource consumption and use information for a customer, and in particular for a customer having a number of different sites. In the past, tracking and accounting for resource consumption has typically been done by each individual customer. Needless to say, this is a very time-consuming and expensive proposition.

Detailed Description Text (4):
In a preferred implementation, a central database is developed and contains information pertaining to different corporate and/or individual facilities. Information such as billing history for utility resource usage, structure information (such as square footage and structure characteristics), servicing utility resource provider and/or utility resource providers, and utility resource

account information can be, and preferably is incorporated into the database. Other types of information can be incorporated, as will become apparent below.

Detailed Description Text (6):
In accordance with one aspect of the invention, billing information which is received from each resource provider is scrutinized in accordance with a plurality of predefined or pre-determined tolerance parameters. Any information which does not meet with one or more of the tolerance parameters can be flagged for remedial processing. In accordance with a preferred aspect of the invention, scrutinization is performed by the host computer in accordance with a variety of algorithmic checks which are implemented in software. The tolerance parameters are preferably calculated through utilization of the billing information for each resource provider.

Detailed Description Text (14):
In view of the foregoing computer system description and in accordance with one aspect of the invention, the reader is referred to FIG. 2. There, an exemplary computer system or host system 20 can be seen to comprise part of a system which includes a resource provider 32 and a customer 34. In the context of this document, the term "resource provider" will be understood to include a company or other source from which resources in the form of goods, services and/or commodities originate. In a preferred implementation, such resource provider can comprise one or more utility resource providers, e.g. providers of electricity, water, sewage services, natural gas, propane, alternate energy sources and/or other related goods or services or processes. Similarly, the term "customer" as used in this document will be understood to include an individual, company, companies or sites which consume resources from one or more resource providers. In a preferred implementation, such customers consume one or more utility resources for which it is desired to account.

Detailed Description Text (16):
At step 220 (FIG. 5) resource usage information from resource provider 32 is received into host computer 22. The resource usage information pertains to consumption of at least one resource by the customer. The resource usage information can be introduced into system 20 in any suitable way. In one embodiment, such information from resource provider 32 is received electronically, via a suitable data link with host computer 20, using one or more of the Internet protocols mentioned above. Alternately, resource usage information can be received in hard-copy form and entered into the host computer as by manual data entry. Other methods and systems can, of course, be utilized to permit such information to be received by host computer 20.

Detailed Description Text (19):
In one aspect of the invention, an audit process is provided at step 240 (FIG. 5). The audit process is preferably implemented in a suitable software application which is resident upon the hardware platform defined by host computer 22. Audit process 240 includes a definition step, at step 250, wherein at least one, and preferably more pre-determined tolerance parameters are defined. At step 260, the resource usage information which is received from resource provider 32 is checked against the pre-determined tolerance parameter(s) for determining whether the information satisfies such parameter(s). If the resource usage information does not satisfy the pre-determined tolerance parameter, then, in accordance with one aspect of the invention, the information from the resource provider is flagged for remedial processing, either manually or electronically, which includes error checking the information.

Detailed Description Text (24):
Customer 34 can be subsequently provided with remote electronic access to the viewable data preferably through the interface device 30 (FIG. 1). Remote access is preferably provided through a remote computer, such as the one shown in FIG. 6, which is linkable with host computer 22 through a protocol, such as one suitable for use within an Internet-based system. In particular, and in connection with a preferred implementation, host computer 22 provides or otherwise defines an Internet website. The various usage information received and processed by host computer 22 from resource provider 32 is provided on the Internet site and can be remotely accessed by the customer. Preferably, access to information contained on host

computer 22 is password-protected such that only the intended customer can access its relevant information. In this way, centralized, computer-accessible, resource accounting methods and systems are provided which are "proactive" in the sense that the customer can, on its own time and terms, access its relevant usage-based information. Further, an audit process is provided to scrutinize the resource usage information to ensure that the information utilized to generate the computer-viewable data is within acceptable tolerances levels.

Detailed Description Text (25):
Referring to FIG. 3, an implementation in accordance with another aspect of the invention is set forth generally at 36. In this implementation, a plurality of resource providers 38, 40, 42, and 44 provide resource usage information to host computer 20 such that the host computer can process the information as described immediately above. The resource providers need not be related to one another and can comprise separate companies. Alternately, the resource usage information provided by resource providers 38-44 can originate from one resource provider and can constitute a plurality of different resources, e.g. electric power, water, natural gas, sewer services, and the like. Such would be the case, for example, if one resource provider were to provide all of the pertinent resources which are utilized by a particular consumer. Of course, the above-described tolerance parameters which are effectuated through the audit processor function can be, and preferably are implemented for the resource usage information which is received from each of the resource providers.

Detailed Description Text (27):
Again, centralized, computer-accessible, interactive resource management methods and systems are provided which are "proactive" in the sense that the customer can, on its own time and terms, access its relevant resource usage information. Further, a system is provided which can receive resource usage input from a number of different resource providers. Further still, a system is provided which can tolerance check the resource usage information received from each of the resource providers to ensure accurate reporting thereof to the customer. Accordingly, very streamlined, efficient, and accurate resource management and accounting systems and processes are provided by the various implementations of the invention.

Detailed Description Text (28):
Referring to FIG. 4, another implementation in accordance with the invention is set forth generally at 46. There, it can be seen that a plurality of resource providers 38-44 have access to, or are otherwise capable of providing resource usage information to computer system 20. A plurality of customers 48, 50, 52, and 54 preferably have remote electronic access to computer system 20 in much the way as was described above. It is to be understood that although only four resource providers and four customers are utilized in the illustration, many more of both are contemplated.

Detailed Description Text (29):
In this example, a database within host system 20 receives and stores information associated with each of customers 48-54. Resource usage information is received into host computer 20 from resource providers 38-44. Such information, for each of both the resource providers and the customers, is preferably tolerance checked as described above, to ensure the accuracy of such information. Such information is further preferably processed into computer-viewable, usage-based data associated with each customer's consumption of the resource. In a preferred embodiment, the resource comprises a utility resource. Preferably a plurality of different utility resources are managed and tracked by the inventive systems and methodologies. Such processed information is preferably made available, through remote computer terminal access, to each of the customers.

Detailed Description Text (30):
Again, computer-accessible, interactive resource management methods and systems are provided which are "proactive" in the sense that the consumer can, on its own time and terms, access its relevant resource usage information. Further, a system is provided which receives resource usage information from a number of different resource providers, checks the resource usage information against one or more tolerance parameters, processes such information and makes it available to the

customers via electronic link. In this implementation a plurality of different customers are incorporated into the system of the present invention. Accordingly, very streamlined, accurate, and efficient systems and processes are provided by the various implementations of the invention.

Detailed Description Text (31):
Referring to FIG. 7, a preferred implementation of the invention is set forth generally at 56. Similar to the above implementation, a computer system 20 is provided and includes a host computer 22 as described above. Information for a plurality of customers 58, 60, and 62 is stored in a database as described above. Each customer can, but need not, comprise a plurality of different sites which may or may not be geographically separated. The customers are customers and consumers of utility resources provided by a plurality of different utility resource providers 64, 66, 68, and 70. Each customer may, however, be a customer of only one utility resource provider. Alternately, each customer may be a customer of more than one utility resource provider. Where a customer has many different geographically-separated sites, utility resources such as electricity, water, gas, and/or other related utility resource services could conceivably be provided by a large number of utility resource companies or providers. Utility resource usage information is received from each utility resource company into host computer 22 as described above in connection with step 220 (FIG. 5). The usage information pertains to consumption of utility resources by each site of each customer and includes, as mentioned above, cost-related and quantity-related consumption variables. Such information is preferably tolerance checked in accordance with the above-described audit processor to ensure the accuracy thereof. Preferably, tolerance checking is performed for each of the utility resource providers for each of their relevant customers. Such information is preferably subsequently processed as described and customers 58-62 are provided with remote electronic access to computer-viewable data in host computer 20 through interface device 30 (FIG. 1) as described above. Such computer-viewable data is preferably in the form of a plurality of different graphical reports which can be selected by the customer for viewing on a computer which is remote from the host computer.

Detailed Description Text (32):
The inventive methodologies and systems described just above are particularly useful in the context of utility resource customers having a number of different, geographically-separated sites (such as nationwide) which are serviced by a plurality of different utility resource providers.

Detailed Description Text (33):
For example, and with reference to FIG. 7, customer 58 includes sites 58a, 58b, and 58c. Although only three exemplary sites are used, it will be understood that such sites can comprise any number of different sites which may or may not be geographically-separated. Similarly, customer 60 includes site 60a, 60b, and 60c. Likewise, customer 62 includes site 62a, 62b, and 62c. For purposes of example only, assume that each geographically-separated site of any of the customers is serviced by a different utility resource provider or company. Each utility resource provider is able to, through the inventive methodologies and systems, provide usage information for each specific geographically-separated site to computer system 20. Such information is received and processed and provided so that each customer, e.g. customers 58, 60, 62, can access and view graphical reports, including numerical and tabulated reports, for each of its sites. In this embodiment, as was briefly mentioned above, the tolerance parameters can be, and preferably are defined to be utility-specific. This gives the customer access to processed, computer-viewable data which includes a desired degree of utility pricing expertise. Such expertise is comprehensive and vast insofar as a large number of utility resource providers are incorporated into the system for an even larger number of customers. Through the preferred tolerance parameter checking, errors or anomalies can be easily detected for correction. In the context of utility providers, customers whose utility usage information is determined to fail one or more of the tolerance parameters can receive an adjustment from the servicing utility, or alternately, can be placed on a correct rate schedule. Alternatively, and in the event there is no error in the usage information, the customer can be advised to modify utility consumption to qualify for a more favorable price, or, may be advised to seek an alternate supplier whose pricing may be more favorable for the customer's existing consumption pattern.

Detailed Description Text (80):
Referring to FIGS. 51, 52A-52B an exemplary screen 192 is shown and describes an aggregated load profile which has been aggregated for the subject time interval. This report gives the customer the added flexibility to uniquely tailor the aggregation report to suit the customer's needs. For example, a customer can select, for aggregation, a date or date range, how aggregation is to be made (i.e., "Total Company", "Region", "State", or by "Utility" or Utility Resource Provider) as shown in FIG. 52A. A plurality of different regions, such as the illustrated "Southwest" region can be selected. Regions can also be thought of as climate zones, business operations areas, and the like. In addition, a customer can select to include or exclude one or more sites from aggregation. In addition to the load profile aggregation, a tabular summary (FIG. 52B) can be provided to give the customer hard numbers describing the particular aggregated period. For example, a summary describes an average, peak, and low demand figure for each day within the period. The summary also identifies load factor and the total kilowatt hours for the particular period. Such quantities are particularly useful in assisting the customer in quantifying and identifying the characteristics of their loads, and providing invaluable information to energy suppliers, i.e. utility resource providers, that serve the customers in a deregulated environment. A customer can also, through a drill-down option, click on a particular day and see that day's aggregated profile as shown in screen 194 in FIG. 53.

Current US Original Classification (1):
705/30

Current US Cross Reference Classification (1):
705/34

Current US Cross Reference Classification (2):
705/412

Current US Cross Reference Classification (3):
707/104.1

US005930773A

United States Patent [19]

Crooks et al.

[11] Patent Number: 5,930,773

[45] Date of Patent: Jul. 27, 1999

[54] **COMPUTERIZED RESOURCE ACCOUNTING METHODS AND SYSTEMS, COMPUTERIZED UTILITY MANAGEMENT METHODS AND SYSTEMS, MULTI-USER UTILITY MANAGEMENT METHODS AND SYSTEMS, AND ENERGY-CONSUMPTION-BASED TRACKING METHODS AND SYSTEMS**

[75] Inventors: **Gerry Crooks**; **Ed Arnhold**; **John Battista**, all of Spokane, Wash.; **Ken Boni**, Hayden Lake; **Dan Bowers**, Boise, both of Id.; **Mark Feichtner**, Spokane, Wash.; **Blaine French**, Spokane, Wash.; **Janna Genzberger**, Spokane, Wash.; **David D. Holmes**, Colbert, Wash.; **Larry Kippenhan**, Greenacres, Wash.; **Dave Miller**; **Shawn Nanto**, both of Spokane, Wash.; **Teri Orr**, Greenacres, Wash.; **Ed Schlect**, Spokane, Wash.

[73] Assignee: **Avista Advantage, Inc.**, Spokane, Wash.

[21] Appl. No.: **08/992,678**

[22] Filed: **Dec. 17, 1997**

[51] **Int. Cl.**[6] **G06F 17/60**

[52] **U.S. Cl.** **705/30**; 705/34; 705/412; 707/104

[58] **Field of Search** 395/200.3, 200.33, 395/200.47, 200.48, 200.49; 705/1, 30, 34, 400, 412, 413; 707/104; 709/200, 203, 217, 218, 219

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,684,951	8/1972	Goldman et al.	395/188.01
3,852,571	12/1974	Hall et al.	235/61.7 B
4,485,300	11/1984	Peirce	235/380
4,701,601	10/1987	Francini et al.	235/449
4,734,564	3/1988	Boston et al.	235/380
4,803,632	2/1989	Frew et al.	705/412

(List continued on next page.)

FOREIGN PATENT DOCUMENTS

0745947A2 12/1996 European Pat. Off. .

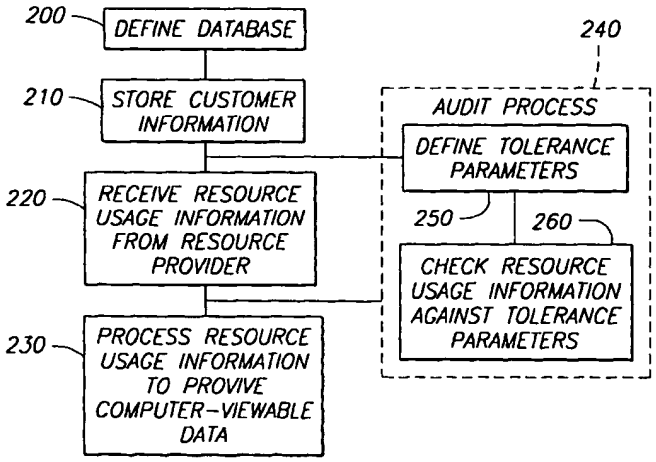
Primary Examiner—Edward R. Cosimano

Attorney, Agent, or Firm—Wells, St. John, Roberts, Gregory & Matkin, P.S.

[57] **ABSTRACT**

Computerized resource accounting methods and systems, and in particular computerized utility resource management methods and systems, multi-user utility resource management methods and systems, and energy-consumption-based tracking methods and systems are described. In one implementation, a host computer includes a processor, an interface device and a database defined therein for maintaining information pertaining to one or more customers of one or more resources. Resource usage information is received into the host computer pertaining to consumption of one or more of the resources by one or more of the customers at one or more customer site. The resource usage information is processed to provide usage-based, computer-viewable data associated with a respective customer's consumption of one or more of the resources. In a preferred aspect, each customer is provided with computer access to the computer-viewable data through the interface device, wherein the customer can view the data at a location which is remote from the host computer. Preferably, the computer-viewable data comes in the form of a plurality of different graphical reports, including numerical and tabulated reports, which can be selected by a customer. For customers with multiple sites, the viewable data for the various sites can be viewed remotely and in a plurality of different report formats. In a preferred implementation, utility resource usage information, e.g. electricity, gas, water, etc. . . , is tracked, maintained, and made available to facilitate decision making.

106 Claims, 78 Drawing Sheets



L5: Entry 6 of 7 File: USPT Apr 21, 1998

DOCUMENT-IDENTIFIER: US 5742772 A
TITLE: Resource management system for a broadband multipoint bridge

Abstract Text (1):
An electronic bridge resource management system, having a programmatically-implemented processing system. A bridge service interfaces with a plurality of clients and receives a quality of service (QOS) specification from each of the clients. A resource manager receives a QOS specification from the bridge service, distributes at least one QOS constraint associated with the QOS specification across flow processing modules of a channel, determines resource requirements for each of the flow processing modules, and then determines whether bridge resources can be allocated to meet the QOS specification. The clients may alter their QOS specifications and retry if the resource manager denies them admission because of a lack of available bridge resources.

Detailed Description Text (38):
In general terms, a QOS contract is an agreement with a resource provider for use of that resource to satisfy a specific performance requirement. QOS defines the expected performance for data transport on a flow. It is specified as a set of parameters describing the type of QOS contract, traffic and performance. Broadband networks are designed to support QOS contracts on an end to end basis. In the system of the present invention, these contracts are extended to encompass bridge operation.

Current US Original Classification (1):
709/226

Current US Cross Reference Classification (3):
709/229

Current US Cross Reference Classification (4):
709/240

US005742772A

United States Patent [19]

Sreenan

[11] Patent Number: 5,742,772

[45] Date of Patent: Apr. 21, 1998

[54] **RESOURCE MANAGEMENT SYSTEM FOR A BROADBAND MULTIPOINT BRIDGE**

[75] Inventor: **Cormac J. Sreenan**, Green Village, N.J.

[73] Assignee: **Lucent Technologies Inc.**, Murray Hill, N.J.

[21] Appl. No.: **851,056**

[22] Filed: **May 5, 1997**

Related U.S. Application Data

[63] Continuation of Ser. No. 560,446, Nov. 17, 1995, abandoned.

[51] **Int. Cl.**[6] **G06F 15/176**

[52] **U.S. Cl.** **395/200.56**; 395/200.7; 395/200.59; 370/17; 370/54; 370/85.13

[58] **Field of Search** 395/200.56, 200.7, 395/200.59; 370/85.13, 17, 54

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,905,282	2/1990	McGlynn et al.	380/48
5,086,426	2/1992	Tsukakoshi et al.	370/85.13
5,131,016	7/1992	Broughton et al.	375/240
5,309,437	5/1994	Perlman et al.	370/85.13
5,341,477	8/1994	Pitkins et al.	395/200.09
5,426,637	6/1995	Derby et al.	370/85.13
5,461,611	10/1995	Drake, Jr. et al.	370/54
5,485,455	1/1996	Dobbins et al.	370/60
5,509,123	4/1996	Dobbins et al.	395/200.15
5,526,344	6/1996	Diaz et al.	370/16
5,530,695	6/1996	Dighe et al.	370/17

OTHER PUBLICATIONS

"Video conferencing, file storage, and management in multimedia computer systems", Rangan, P.V., *Computer Networks and ISDN Systems 25,* (1993) pp. 901–919.

"Panel–Discussion Multimedia Conferencing over ATM Network", Wakahara, T., and Unemoto, K., *IEEE Com. Soc. Int. Conf. On Multimedia Communications,* May 1994.

"Multipoint Multimedia Conferencing", Clark, W.J., *IEEE Communications Magazine,* May 1992, pp. 44–50.

"Issues of Reserving Resources in Advance", Wolf, L.C., et al., 5th Int. Workshop on Network and Op. Sys. Support For Digital Audio & Video, Apr. 1995.

"A Standards–Based Multimedia Conferencing Bridge", Horn, D.N., et al., *AT&T Technical Journal,* Jan./Feb. 1993, pp. 41–49.

"A Versatile Audio Bridge for Multimedia Conferencing", Horn, D.N. and Sharma, A., *Proc. of IEEE ICC '94,* pp. 1754–1762.

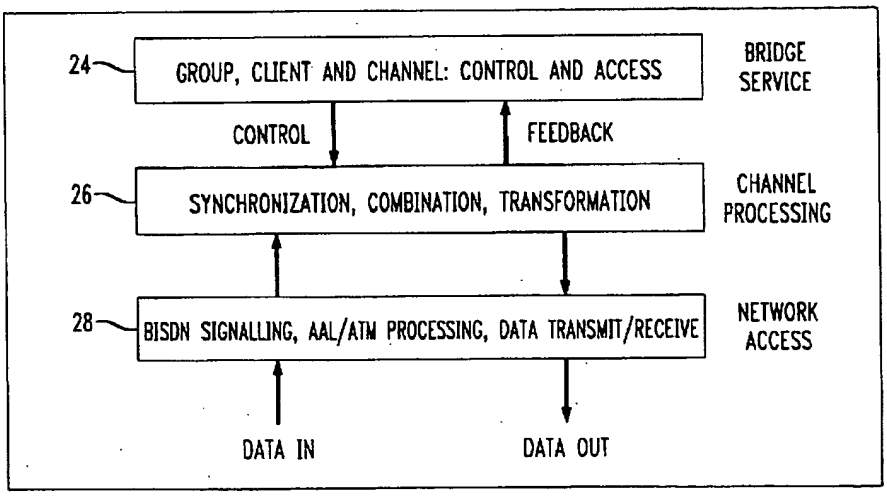
"Montage: Continuous Presence Teleconferencing Utilizing Compressed Domain Video Bridging", Gaglianello, R.D., and Cash, G.L., *Proc. of IEEE ICC '95,* pp. 573–581.

Primary Examiner—Robert B. Harrell
Assistant Examiner—Saleh Najjar

[57] **ABSTRACT**

An electronic bridge resource management system, having a programmatically-implemented processing system. A bridge service interfaces with a plurality of clients and receives a quality of service (QOS) specification from each of the clients. A resource manager receives a QOS specification from the bridge service, distributes at least one QOS constraint associated with the QOS specification across flow processing modules of a channel, determines resource requirements for each of the flow processing modules, and then determines whether bridge resources can be allocated to meet the QOS specification. The clients may alter their QOS specifications and retry if the resource manager denies them admission because of a lack of available bridge resources.

20 Claims, 5 Drawing Sheets



L5: Entry 7 of 7 File: USPT Apr 22, 1997

DOCUMENT-IDENTIFIER: US 5623404 A
TITLE: System and method for producing schedules of resource requests having uncertain durations

Abstract Text (1):
A system and method for scheduling resource requests for a resource provider generate a first schedule, based on expected durations of each resource request, and a second schedule, based on longer, pessimistic durations of each resource request. A user interface simultaneously displays the first and second schedules to a system user. The first schedule provides the system user with a guide to good overall management of the resource performance. The second schedule provides the system user with a guide for making time commitments to customers with a greater degree of confidence. The system and method employ a variety of techniques including statistic probability calculations to determine expected and pessimistic durations for each resource request, and incorporate features for updating the first and second schedules in response to dynamic changes in the resource environment.

Brief Summary Text (2):
The present invention relates to resource management, and, more particularly, to techniques for scheduling resource requests assigned to a resource provider.

Brief Summary Text (4):
Resource scheduling problems are a concern in many organizations in which a plurality of resource requests are assigned to an individual resource provider. If the individual resource provider cannot handle all resource requests simultaneously, a schedule must be generated. The schedule must define a time-ordered sequence of the resource requests assigned to the individual resource provider, and specify particular times at which the resource provider is to serve each resource request. Techniques for generating a schedule consider time-related factors such as the priorities and durations of the resource requests, and transition times between consecutively scheduled resource requests.

Brief Summary Text (5):
The durations of the resource requests, in particular, greatly affect the efficient scheduling of future resource requests, as well as the ability to make time commitments to the entities requesting resources. The duration of a resource request refers to the amount of time that a resource provider requires to serve the request, and a time commitment refers to a promised time at which the resource provider is to start to serve the request. In a complete schedule, the resource requests are each assigned start and completion times based on the expected durations of preceding resource requests and transition times. However, the durations of resource requests inevitably vary with the type of resources requested, and even vary for resource requests involving the same types of resources. Variation in the duration of a resource request will introduce variability into its completion time, and that variability will propagate to the start times of subsequent resource requests. This variation makes reliable scheduling very difficult.

Brief Summary Text (6):
Existing scheduling systems employ two basic approaches to the uncertainty problem. The first approach simply assumes a fixed duration for resource requests involving the same types of resources, based on past experience. This approach addresses the variation in the durations of resource requests involving different types of resources, but ignores the potential uncertainty in the durations of resource requests of the same type. Thus, confidence in the ability to make time commitments remains low. The second approach attempts to accommodate the uncertainty by

incorporating a degree of slack into the schedule based on predicted maximums for the durations of particular types of resource requests. This margin of error enables more confident time commitments, but results in an inefficient use of the resource provider's time.

Brief Summary Text (7):
One example of the foregoing scheduling problem arises in the context of a field service environment. A field service environment exists in many organizations, characterized by a group of field service technicians dedicated to the repair and maintenance of a variety of industrial machines, office equipment, and the like. The field service technicians travel to a customer's location to perform routine maintenance of the customer's equipment and to provide repair services pursuant to customer service calls scheduled by a service call dispatcher. Thus, in the field service environment, the technicians act as resource providers, performing maintenance and repair services in response to resource requests in the form of routine maintenance appointments and customer service calls.

Brief Summary Text (12):
To achieve the foregoing advantages, as broadly embodied and described herein, the present invention provides, in one aspect, a system and method for scheduling a plurality of resource requests for a resource provider, wherein each of the resource requests has an uncertain duration. To schedule the resource requests, the system and method determine first potential durations for the resource requests, determine second potential durations for the resource requests, generate a sequence of the resource requests, generate a first schedule of the resource requests by assigning a first start time to each of the resource requests following a first one of the resource requests in the sequence based on a sum of the first potential durations determined for the preceding resource requests in the sequence, and generate a second schedule of the resource requests by assigning a second start time to each of the resource requests following the first one of the resource requests in the sequence based on a sum of the second potential durations determined for the preceding resource requests in the sequence.

Brief Summary Text (13):
In another aspect, the present invention provides a system and method for scheduling a plurality of resource requests for a resource provider, wherein each of the resource requests has an uncertain duration, and each of the resource requests is associated with one of a plurality of different types of activities. To schedule the resource requests, the system and method match each of the resource requests with one of a plurality of probability distributions for a potential duration of the respective resource request based on the type of activity associated with the respective resource request, generate a sequence of the resource requests, generate a first combined probability distribution for each of the resource requests, the first combined probability distribution combining the probability distributions matched with each of the preceding resource requests in the sequence, select a probability level, compute, for each of the resource requests, a duration in the first combined probability distribution for the respective resource request based on the probability level, and generate a schedule of the resource requests by assigning a start time to each of the resource requests following the first one of the resource requests in the sequence based on the duration in the first combined probability distribution computed for the respective resource request.

Current US Original Classification (1):
705/9

CLAIMS:

1. A computer-implemented method for scheduling a plurality of resource requests for a resource provider, wherein each of said resource requests has an uncertain duration, and each of said resource requests is associated with one of a plurality of different types of activities, said method comprising the steps of:

matching each of said resource requests with one of a plurality of probability distributions for a potential duration of the respective resource request based on the type of activity associated with said respective resource request;

generating a sequence of said resource requests;

generating, for each of said resource requests, a first combined probability distribution, said first combined probability distribution combining the probability distributions matched with each of the preceding resource requests in said sequence;

selecting a probability level;

computing, for each of said resource requests, a first duration in the first combined probability distribution for the respective resource request based on said probability level;

generating a first schedule of said resource requests by assigning a start time to each of said resource requests following said first one of said resource requests in said sequence based on the first duration in said first combined probability distribution computed for the respective resource request based on said probability level;

determining second durations for said resource requests, wherein the second durations are different than the first durations; and

generating a second schedule of said resource requests by assigning a second start time to each of said resource requests following said first one of said resource requests in said sequence based on a sum of the second durations determined for the preceding resource requests in said sequence.

2. The method of claim 1, wherein said matching step includes matching each of said resource requests with one of said plurality of probability distributions based on the type of activity associated with said respective resource request and further based on an identity of said resource provider.

3. The method of claim 2, wherein each of said resource requests is a field service call and said resource provider is a field service technician.

4. The method of claim 1, wherein each of said resource requests is a field service call and said resource provider is a field service technician.

6. The method of claim 5, wherein each of said resource requests is a field service call and said resource provider is a field service technician.

7. The method of claim 1, further comprising the steps of:

monitoring actual durations of each of said preceding resource requests completed by said resource provider;

monitoring actual running durations of said preceding resource requests actively served by said resource provider;

generating, for each of said resource requests not completed and not actively served by said resource provider, a new first combined probability distribution, said new first combined probability distribution combining the probability distributions matched with each of the preceding resource requests in said sequence not completed and not actively served by said resource provider;

computing, for each of said resource requests not completed and not actively served by said resource provider, a duration in the new first combined probability distribution for the respective resource request based on said probability level; and

modifying said first schedule by assigning a start time to each of said resource requests not completed and not actively served by said resource provider based on the duration in said new first combined probability distribution computed for the respective resource request based on said probability level.

8. The method of claim 7, wherein each of said resource requests is a field service call and said resource provider is a field service technician.

10. The method of claim 9, wherein each of said resource requests is a field service call and said resource provider is a field service technician.

12. The method of claim 11, wherein each of said resource requests is a field service call and said resource provider is a field service technician.

13. A system for scheduling a plurality of resource requests for a resource provider, wherein each of said resource requests has an uncertain duration, and each of said resource requests is associated with one of a plurality of different types of activities, said system comprising:

means for matching each of said resource requests with one of a plurality of probability distributions for a potential duration of the respective resource request based on the type of activity associated with said respective resource request;

means for generating a sequence of said resource requests;

means for generating, for each of said resource requests, a first combined probability distribution, said first combined probability distribution combining the probability distributions matched with each of the preceding resource requests in said sequence;

means for selecting a probability level; means for computing, for each of said resource requests, a duration in the first combined probability distribution for the respective resource request based on said probability level;

means for generating a first schedule of said resource requests by assigning a start time to each of said resource requests following said first one of said resource requests in said sequence based on the duration in said first combined probability distribution computed for the respective resource request;

means for determining second durations for said resource requests, wherein the second durations are different than the first durations; and

means for generating a second schedule of said resource requests by assigning a second start time to each of said resource requests following said first one of said resource requests in said sequence based on a sum of the second durations determined for the preceding resource requests in said sequence.

14. The system of claim 13, wherein said matching means includes means for matching each of said resource requests with one of said plurality of probability distributions based on the type of activity associated with said respective resource request and further based on an identity of said resource provider.

15. The system of claim 14, wherein each of said resource requests is a field service call and said resource provider is a field service technician.

16. The system of claim 13, wherein each of said resource requests is a field service call and said resource provider is a field service technician.

18. The system of claim 17, wherein each of said resource requests is a field service call and said resource provider is a field service technician.

19. The system of claim 13, further comprising:

means for monitoring actual durations of each of said preceding resource requests completed by said resource provider and for monitoring actual running durations of each of said preceding resource requests actively served by said resource provider;

means for generating, for each of said resource requests not completed and not

actively served by said resource provider, a new first combined probability distribution, said new first combined probability distribution combining the probability distributions matched with each of the preceding resource requests in said sequence not completed and not actively served by said resource provider;

means for computing, for each of said resource requests not completed and not actively served by said resource provider, a duration in the new first combined probability distribution for the respective resource request based on said probability level; and

means for modifying said first schedule by assigning a start time to each of said resource requests not completed and not actively served by said resource provider based on the duration in said new first combined probability distribution for the respective resource request computed based on said probability level.

20. The system of claim 19, wherein each of said resource requests is a field service call and said resource provider is a field service technician.

22. The system of claim 21, wherein each of said resource requests is a field service call and said resource provider is a field service technician.

24. The system of claim 23, wherein each of said resource requests is a field service call and said resource provider is a field service technician.

25. A computer-implemented method for scheduling a plurality of resource requests for a resource provider, wherein each of said resource requests has an uncertain duration, and each of said resource requests is associated with one of a plurality of different types of activities, said method comprising the steps of:

matching each of said resource requests with one of a plurality of probability distributions for a potential duration of the respective resource request based on the type of activity associated with said respective resource request;

generating a sequence of said resource requests;

generating, for each of said resource requests, a first combined probability distribution, said first combined probability distribution combining the probability distributions matched with each of the preceding resource requests in said sequence;

selecting a first probability level;

selecting a second probability level, wherein the second probability level is different than the first probability level;

computing, for each of said resource requests, a first duration in the first combined probability distribution for the respective resource request based on said first probability level;

computing, for each of said resource requests, a second duration in the first combined probability distribution for the respective resource request based on said second probability level;

generating a first schedule of said resource requests by assigning a start time to each of said resource requests following said first one of said resource requests in said sequence based on the first duration in said first combined probability distribution computed for the respective resource request based on said first probability level; and

generating a second schedule of said resource requests by assigning a start time to each of said resource requests following said first one of said resource requests in said sequence based on the second duration in said first combined probability distribution computed for the respective resource request based on said second probability level.

27. The method of claim 25, further comprising the steps of:

monitoring actual durations of each of said preceding resource requests completed by said resource provider;

monitoring actual running durations of said preceding resource requests actively served by said resource provider;

generating, for each of said resource requests not completed and not actively served by said resource provider, a new first combined probability distribution, said new first combined probability distribution combining the probability distributions matched with each of the preceding resource requests in said sequence not completed and not actively served by said resource provider;

computing, for each of said resource requests not completed and not actively served by said resource provider, a first duration in the new first combined probability distribution for the respective resource request based on said first probability level;

computing, for each of said resource requests not completed and not actively served by said resource provider, a second duration in the new first combined probability distribution for the respective resource request based on said second probability level;

modifying said first schedule by assigning a start time to each of said resource requests not completed and not actively served by said resource provider based on the first duration in said new first combined probability distribution computed for the respective resource request based on said first probability level; and

modifying said second schedule by assigning a start time to each of said resource requests not completed and not actively served by said resource provider based on the second duration in said new first combined probability distribution computed for the respective resource request based on said second probability level.

28. The method of claim 25, wherein each of said resource requests is a field service call and said resource provider is a field service technician.

29. A computer-implemented system for scheduling a plurality of resource requests for a resource provider, wherein each of said resource requests has an uncertain duration, and each of said resource requests is associated with one of a plurality of different types of activities, said system comprising:

means for matching each of said resource requests with one of a plurality of probability distributions for a potential duration of the respective resource request based on the type of activity associated with said respective resource request;

means for generating a sequence of said resource requests;

means for generating, for each of said resource requests, a first combined probability distribution, said first combined probability distribution combining the probability distributions matched with each of the preceding resource requests in said sequence;

means for selecting a first probability level;

means for selecting a second probability level, wherein the second probability level is different than the first probability level;

means for computing, for each of said resource requests, a first duration in the first combined probability distribution for the respective resource request based on said first probability level;

means for computing, for each of said resource requests, a second duration in the first combined probability distribution for the respective resource request based on

said second probability level;

means for generating a first schedule of said resource requests by assigning a start time to each of said resource requests following said first one of said resource requests in said sequence based on the first duration in said first combined probability distribution computed for the respective resource request based on said first probability level; and

means for generating a second schedule of said resource requests by assigning a start time to each of said resource requests following said first one of said resource requests in said sequence based on the second duration in said first combined probability distribution computed for the respective resource request based on said second probability level.

31. The system of claim 29, further comprising:

means for monitoring actual durations of each of said preceding resource requests completed by said resource provider;

means for monitoring actual running durations of said preceding resource requests actively served by said resource provider;

means for generating, for each of said resource requests not completed and not actively served by said resource provider, a new first combined probability distribution, said new first combined probability distribution combining the probability distributions matched with each of the preceding resource requests in said sequence not completed and not actively served by said resource provider;

means for computing, for each of said resource requests not completed and not actively served by said resource provider, a first duration in the new first combined probability distribution for the respective resource request based on said first probability level;

means for computing, for each of said resource requests not completed and not actively served by said resource provider, a second duration in the new first combined probability distribution for the respective resource request based on said second probability level;

means for modifying said first schedule by assigning a start time to each of said resource requests not completed and not actively served by said resource provider based on the first duration in said new first combined probability distribution computed for the respective resource request based on said first probability level; and

means for modifying said second schedule by assigning a start time to each of said resource requests not completed and not actively served by said resource provider based on the second duration in said new first combined probability distribution computed for the respective resource request based on said second probability level.

32. The system of claim 29, wherein each of said resource requests is a field service call and said resource provider is a field service technician.

US005623404A

United States Patent [19]

Collins et al.

[11] Patent Number: 5,623,404

[45] Date of Patent: Apr. 22, 1997

[54] **SYSTEM AND METHOD FOR PRODUCING SCHEDULES OF RESOURCE REQUESTS HAVING UNCERTAIN DURATIONS**

[75] Inventors: **John E. Collins**, Hudson, Wis.; **Elizabeth M. Sisley**, Woodbury, Minn.

[73] Assignee: **Minnesota Mining and Manufacturing Company**, St. Paul, Minn.

[21] Appl. No.: **210,678**

[22] Filed: **Mar. 18, 1994**

[51] **Int. Cl.**[6] **G06F 17/60**

[52] **U.S. Cl.** **395/209**

[58] **Field of Search** 364/401, 402, 364/403, 468

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,092,718	5/1978	Wendt .	
4,212,069	7/1980	Baumann .	
4,799,162	1/1989	Shinkawa et al. .	
4,937,743	6/1990	Rassman et al.	364/401
5,009,431	4/1991	Natarajan	364/468
5,093,794	3/1992	Howie et al.	364/468
5,111,391	5/1992	Fields et al.	364/401
5,122,959	6/1992	Nathanson et al. .	
5,148,365	9/1992	Dembo	364/402
5,241,465	8/1993	Oba et al.	364/401
5,325,292	6/1994	Crockett	364/401
5,406,476	4/1995	Deziel, Jr. et al.	364/402

OTHER PUBLICATIONS

A. V. Hill and D. C. Whybark, "Chexpedite: A Computer-Based Approach to the Bank Courier Problem," *Decision Sciences,* vol. 13, No. 2, Apr. 1982, pp. 251–265.

M. S. Fox and S. F. Smith, "ISIS—a knowledge-based system for factory scheduling," *Expert Systems,* vol. 1, No. 1, 1984, pp. 25–49.

A. V. Hill and D. C. Whybark, "Comparing Exact Solution Procedures for the Multi-Vehicle Routing Problem," *The Logistics and Transportation Review,* vol. 12, No. 3, 1976, pp. 145–153.

T. Dean and M. Boddy, "An Analysis of Time-Dependent Planning," in Proceedings of the Seventh National Conference on Artificial Intelligence, A.A.A.I., 1988, pp 49–54.

H. Berliner and G. Goetsch, "A Study of Search Methods: The Effect of Constraint Satisfaction and Adventurousness," in Proceedings of the Ninth International Joint Conference on Artificial Intelligence, vol. 2, Aug. 18–23, 1985, pp. 1079–1082.

A. V. Hill, J. D. Naumann, and N. L. Chervany, "SCAT and SPAT:" Large-Scale Computer-Based Optimization Systems for the Personnel Assignment Problem, *Decision Sciences,* vol. 14, No. 2, Apr. 1983, pp. 207–220.

B. Kalantari, A. V. Hill, and S. R. Arora, "An algorithm for the traveling salesman problem with pickup and delivery customers," *European Journal of Operational Reserach,* vol. 22, No. 3, Dec. 1985, pp. 377–386.

(List continued on next page.)

Primary Examiner—Robert A. Weinhardt

Attorney, Agent, or Firm—Carolyn A. Bates; Steven J. Shumaker

[57] **ABSTRACT**

A system and method for scheduling resource requests for a resource provider generate a first schedule, based on expected durations of each resource request, and a second schedule, based on longer, pessimistic durations of each resource request. A user interface simultaneously displays the first and second schedules to a system user. The first schedule provides the system user with a guide to good overall management of the resource performance. The second schedule provides the system user with a guide for making time commitments to customers with a greater degree of confidence. The system and method employ a variety of techniques including statistic probability calculations to determine expected and pessimistic durations for each resource request, and incorporate features for updating the first and second schedules in response to dynamic changes in the resource environment.

32 Claims, 12 Drawing Sheets